Slope Response to Drought and Fire: Possible Parallels

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Both fire and drought appear to prime slopes and watersheds for failure and erosion, which could deliver sediment pulses to the estuary. Comparing fire and drought effects on mass wasting and slope stability is centered on the amount, distribution, and movement of water -- a key factor in slope instability --across and through a slope. The primary means by which fire affects the amount/distribution/movement of water (and thus slope instability) is by reducing biomass and making the slope more vulnerable to water once it returns. Drought has some broadly similar effects:

- Fire reduces protective soil cover (alive and dead), leading to more raindrop impacts, more energy per impact, and greater potential for dislodging any single particle. Drought over time reduces this same cover, promoting similar effects.
- Fire indirectly can kill off the root mat; as this mat loses strength, there is greater potential for shallow landslides, ravelling and erosion. Drought over time can weaken this same mat, promoting similar effects.
- Fire and drought both reduce the capacity of a slope to store sediment; they both enhance the delivery of sediment to the local drainage axis, where it is either eroded, awaits erosion, or awaits mobilization as debris flow.

Some slope processes are slowed by drought, whereas fire often has little effect below ground (except for generating hydrophobic layers):

- Clays stay dry, hard, and strong under drought conditions, inhibiting sliding; fire has little effect.
- The effective (grain-to-grain) pressure is high under drought conditions, inhibiting sliding; fire has no effect.
- The soil mass is less dense under drought conditions, inhibiting sliding; fire has no effect.
- Soil creep is slowed under drought conditions; fire has little effect.
- Rock creep may be slowed under drought conditions; fire has little effect.

Post-fire and post-drought sediment pulses are a serious cumulative challenge to the estuary.

Keywords: Fire, drought, sediment, pulse, landslide, slope stability, erosion, mass wasting

Session Title: “End of Drought” – NOT so fast…

Speaker Biography: G. Reid Fisher, PhD, PG, CEG is Principal Geologist for Cal Engineering & Geology. He oversees and performs geologic and geohazard investigations, primarily for agency and public works projects in the greater San Francisco/Monterey Bay Area. His experience includes serving as geomorphologist for contract archeological excavations; Research Geologist for the USGS; and consulting engineering geologist. His main professional interests are in slope stability and earthquake hazards.

Sediment, Salts, and Bed Mobility: Movement Spikes Following Droughts

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Sediment loads will remain elevated or temporarily increase following the end of a drought in many of California's rainfall-dominated watersheds. Salinity and nutrient loads may also discernibly spike as rising groundwater levels mobilize salts and nitrogen compounds from the vadose zone, and deliver them to streams, ponds, springs and seeps once surface/groundwater connections are restored following the drought. These residual trailing effects of drought are thought to be due to:

a. Diminished bank stability, as riparian woodlands die back, leading to continuity gaps and bank erosion.
b. Streams draining riparian woodlands mobilize and "float out" substantial volumes of limbs, snags or trunks, and then erode around the expanded logjams.
c. Rising groundwater tables mobilize salts which have accumulated in the vadose zone; salts in streams can spike 10 to 20 percent during the first wet year or two following droughts, while higher percentages can be observed in off-channel wetlands
d. High nutrient loads that have accumulated in the vadose zone during the drought.

Watershed planning should include provisions for sustaining aquatic and riparian biotic communities both during droughts, and 3 to 4 years after the drought has ended. In watersheds of the San Francisco Estuary (among others), habitat conservation plans may benefit from provisions which help sustain sensitive organisms through a reasonably predictable post-drought period. In rainfall-based watersheds, habitat and recovery planning should be able to draw upon drought-year funding to implement post-drought measures needed to sustain individual species or reaches of particular concern.

Keywords: post-drought recovery, bedload, salinity, salts, nutrients, episodicity, recovery plans,

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Speaker Biography: Barry Hecht, Senior Principal at Balance Hydrologics, has been practicing habitat hydrology since the 1970s. He is a proponent of balanced, integrated consideration of surface and groundwater flows, and for concurrent analysis of sediment transport and water quality, in managing and restoring streams. He often advocates for an episodic consideration of restoration evaluation and design, such that the effects of storms, wildfires, landslides, droughts, and seismic events can be functionally incorporated in channel planning. Mr. Hecht began his career as Santa Cruz County's first Geologist, and then worked under Luna Leopold at the USGS National Bedload Transport Research Facility in Pinedale, Wyoming. Prior to helping establish Balance in 1988, he served as Chief Geologist and Hydrologist for Kleinfelder. He is a registered as a professional geologist, certified engineering geologist, and certified hydrogeologist in California and several other western states.

What Every Resource Plan Should Include Following Droughts

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I believe that the majority of people impacted by California's drought think that when it starts raining again the drought will be over. I certainly wish that were the case but there are some underlying consequences of our State's historic drought that will likely delay the declaration of an official end for some time. This presentation will explore both the positive (yes, positive) and negative effects of long-term drought and what every resource/restoration plan should address for the years ahead specifically in terms of residual impacts on natural resources, ecosystems, private and public properties, local communities, water supply and the San Francisco Bay Estuary.

In order to gain a wider awareness of the long-term effects of prolonged drought it is important to understand the full extent of damages that have occurred and why it will take time and a community-wide planning effort to restore the natural resources that have suffered. Higher runoff volumes, increased erosion and sediment rates and subsequent damages to water quality are expected following drought because of the loss or damage to soil/slope protecting vegetation. It could also take a decade or more for groundwater levels to be restored. Additionally, the hazard/occurrence of wildfire is higher following drought (sometimes for several years) because of excessive buildup of dead or dying vegetation in the landscape.

Individual and community based drought restoration plans should consider such things as: strategies to conserve, reuse/recycle water from existing supplies; development of new and innovative water supplies; groundwater recharge; use of drought tolerant vegetation and lower water using agricultural crops; irrigation water management and monitoring; soil health practices; infrastructure modifications; and other practices that can help prevent damage to natural resources, surface and groundwater supplies, water quality, wildlife and local ecosystems. Sources of information, technical and financial assistance will also be discussed.

Keywords: Response following drought, Resource Plan Restoration Planning, Drought Long-Term effects

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Speaker Biography: Rich Casale has over 41 years of experience with NRCS in the Monterey and San Francisco Bay area. He currently serves as District Conservationist for this USDA agency in Santa Cruz County. He helps agricultural producers and other land users address natural resource issues on properties they own and/or manage and by providing technical advice and services to conservation partners, units of government and others upon their request. He has also helped forward erosion control and conservation programs at the local, state and national level. Rich is a Certified Professional Erosion and Sediment Control Specialist, an international program he co-founded back in 1981. To date, nearly, 10,000 professionals in 13 countries worldwide have become certified. Rich has a Bachelor of Science degree in Natural Resource Management from Humboldt State University. He also owns, manages and practices conservation on his own small ranch in Aptos.